

**Advanced Single Chemistry Alkaline Cleaning
in a STEAG Single Tank Tool**

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INTRODUCTION

The conventional RCA-clean (1) consists of an APM (Ammonia Peroxide Mixture) step, followed by an HPM (Hydrochloride Peroxide Mixture). The APM is known to remove organics, particles and trace metals, but tends to deposit metals on the wafer surface. The subsequent HPM is then supposed to remove these deposited metals. However if the APM solution could be modified in such a way that metal deposition is prevented, it would enable us to omit the HPM step, yielding a Single Chemistry Clean (2). Performing this Single Chemistry Clean on a Single Tank Tool is running a high throughput process on a small footprint tool. This is a new step towards an economical and environmental optimum.

EXPERIMENTAL

The post-clean metal concentration on the wafer surface is the result of equilibrium between precipitation and dissolution of metals originally in the solution or on the wafer surface. Precipitation was investigated by processing clean wafers with contaminated chemicals (1 ppb of Ca, Al, Zn, Cr, Ni, Fe, Cu and Pt). Dissolution was investigated by processing intentionally contaminated wafers ($\pm 1.10^{12}$ at/cm² of the above mentioned metals) with clean chemicals.

P-type monitor wafers (Cz <100>), imec-cleaned, were used. The experiments included both chemical oxide and HF-last wafers. All cleans were performed in a STEAG Single Tank Tool, mounted in a class 1 clean room. The APM used was 1/1/48 in volume-concentration of NH₄OH, H₂O₂ and H₂O respectively at a temperature of 35°C with megasonic energy (420W) applied. For certain experiments an additive modified the APM (APM+). The APM step was followed by a neutral or acidified last rinse (AR), and consecutively Marangoni dried. Surface metal contamination was analyzed by TXRF and AAS. Particle removal efficiency and neutrality were examined on an SP1-TBI.

RESULTS AND DISCUSSION

A standard APM clean tends to contaminate the wafer surface with metals when contaminated chemicals are used (Fig. 1). Acidifying the following rinse step is not enough for this level of contamination to completely remove the metals present at the wafer surface, except in the case of Cr. When using APM+ deposition of metals onto the wafer surface is inhibited for Zn, Cr, Ni, Fe, Cu and to a lesser extent for Ca and Al. The performance of the APM+ is stable over 4h at least. Additionally, the reaction of the additive with Al is time dependent, indeed,

there is less deposition of Al after 4 hours. APM+ makes an acidified rinse superfluous, when clean rinse water is used.

Using APM+ does not improve the removal of metals from the surface (Table I), but prevents the metals, once removed, to redeposit onto the wafer, thus improving overall cleaning efficiency, as can be observed in the case of Zn and Fe. The low removal is due to the low concentration of APM we chose to emphasize the modified deposition behavior. Similar figures are obtained with hydrophobic wafers (data not shown).

Particle behavior is not altered upon modification of the APM mixture (data not shown).

CONCLUSIONS

The feasibility of the proposed single chemistry clean has been investigated. The experiments show that our modified APM, followed by a neutral rinse can be used as a single chemistry alkaline cleaning step with the above mentioned benefits.

REFERENCES

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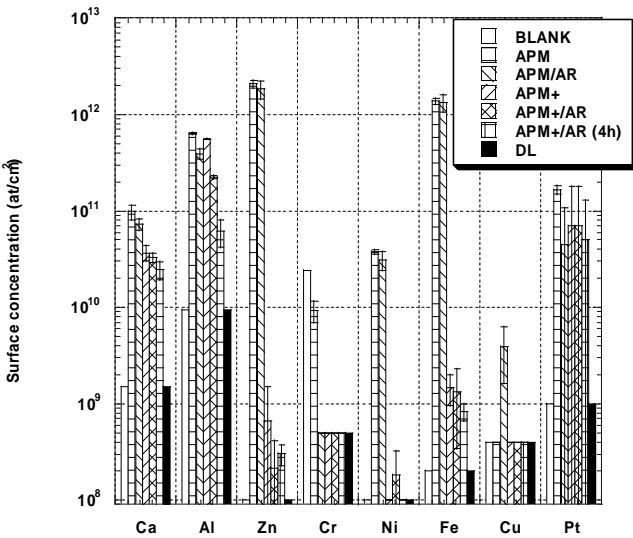


Fig. 1: Deposition from contaminated chemicals onto clean hydrophilic surfaces, using different mixtures.

Table I: Metal cleaning efficiency for contaminated hydrophilic wafers using different clean mixtures (starting condition 10¹² at/cm²)

	APM	APM/AR	APM+	APM+/AR	APM+/AR (4h)	DL
	(%)	(%)	(%)	(%)	(%)	at/cm ²
Ca	99	99	99	99	99	9E+08
Al	0	0	0	12	0	7.2E+09
Zn	29	25	99+	99+	99+	1E+08
Cr	80	62	62	69	58	5E+08
Ni	99+	99+	99+	99+	99+	1E+08
Fe	31	36	90	90	87	2E+08
Cu	99+	99+	99	99	99	1.8E+09
Pt	86	93	93	95	87	7.6E+09